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Wallis

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(54) **AGGREGATE SIGNAL AMPLIFICATION DEVICE AND METHOD**

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Related U.S. Application Data

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(51) **Int. Cl.**

H04B 1/10	(2006.01)
H04B 15/00	(2006.01)
H03F 3/19	(2006.01)
H03F 3/21	(2006.01)

(52) **U.S. Cl.**

CPC ***H04B 1/109*** (2013.01); ***H03F 3/19*** (2013.01); ***H03F 3/21*** (2013.01); ***H04B 1/1027*** (2013.01); ***H04B 15/005*** (2013.01); *H03F 2200/451* (2013.01)

(58) **Field of Classification Search**

CPC H04B 1/06; H04B 1/10; H04B 1/16; H04B 1/18

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,105,949 A *	8/1978	Hardin	H03B 21/02	327/105
2009/0109880 A1*	4/2009	Kim	H04B 1/50	370/278
2010/0304693 A1*	12/2010	Uejima	H04B 1/44	455/83
2013/0043946 A1*	2/2013	Hadjichristos	H04B 1/0057	330/252
2015/0257022 A1*	9/2015	Kohlmann	H04W 24/08	455/550.1
2015/0295594 A1*	10/2015	Kehrer	H04B 1/1027	375/316
2015/0333949 A1*	11/2015	Tasic	H04L 27/2653	370/329
2016/0020862 A1*	1/2016	Morshedi	H04B 17/12	455/77

* cited by examiner

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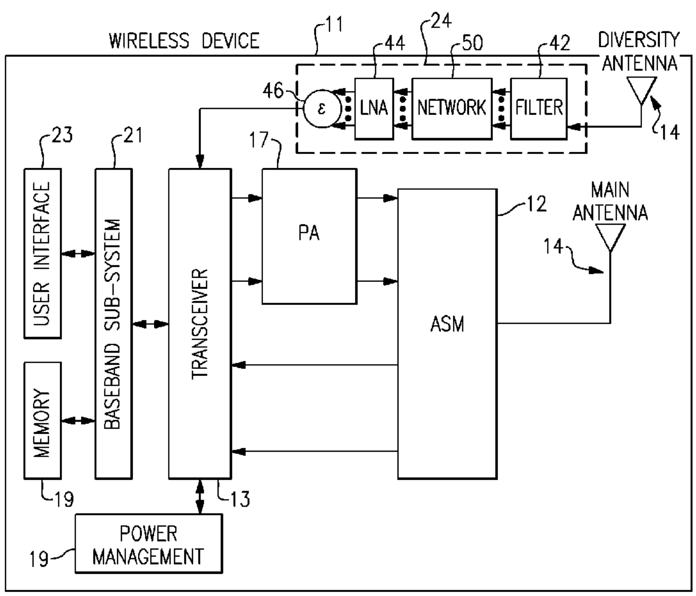
(57) **ABSTRACT**

A surface acoustic wave (SAW) filter that receives an aggregate circuit and outputs two or more sub-signals on outputs each of a different frequency band. The sub-signals are amplified by low noise amplifiers and, in one implementation, the amplified sub-signals can be summed. The outputs are connected via a switched passive network so that portions of the sub-signals on the outputs that are not in the selected frequency band are at least partially terminated.

30 Claims, 8 Drawing Sheets



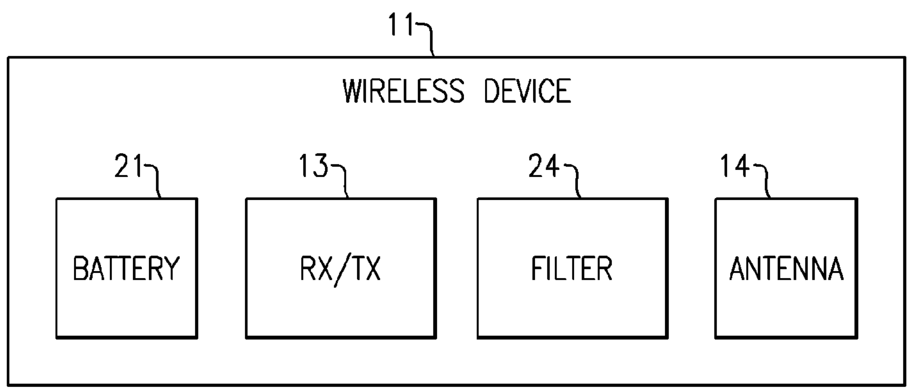


FIG.1

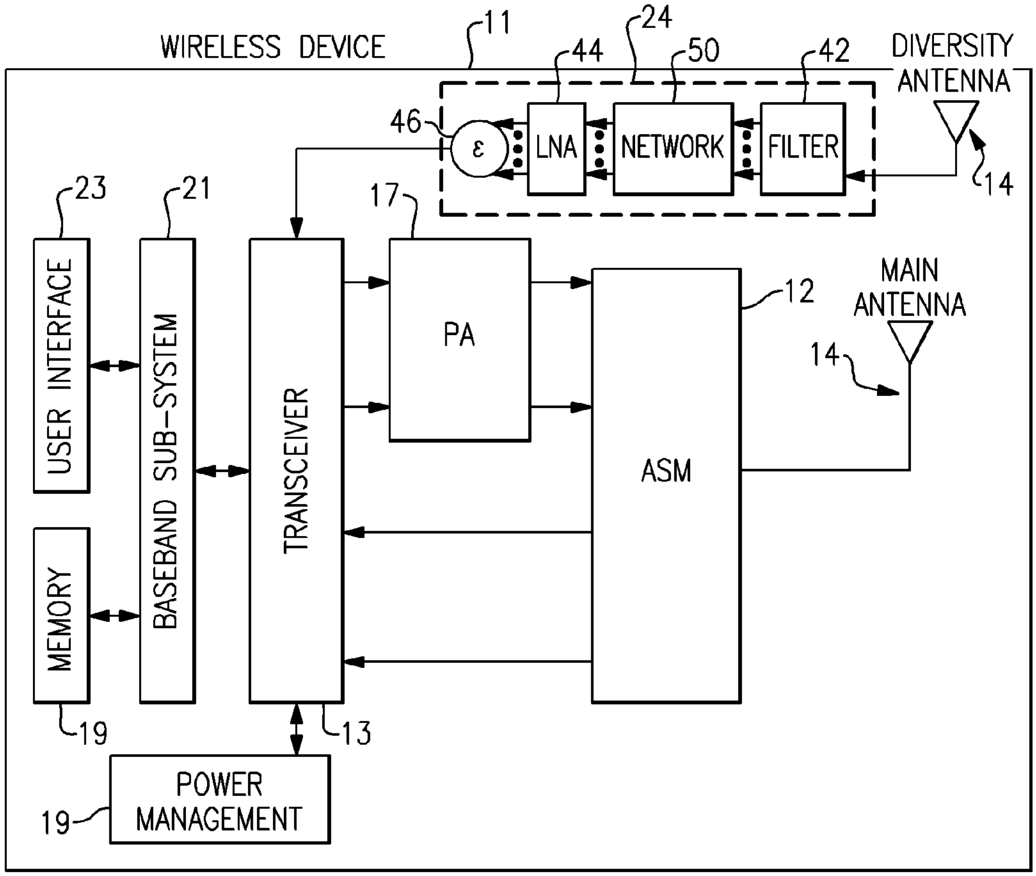

WIRELESS DEVICE
11
24
44
50
42
DIVERSITY ANTENNA
46
ε
LNA
NETWORK
FILTER
14
23
21
17
USER INTERFACE
BASEBAND SUB-SYSTEM
TRANSCEIVER
PA
12
MAIN ANTENNA
14
ASM
MEMORY
19
13
POWER MANAGEMENT
19

FIG.2

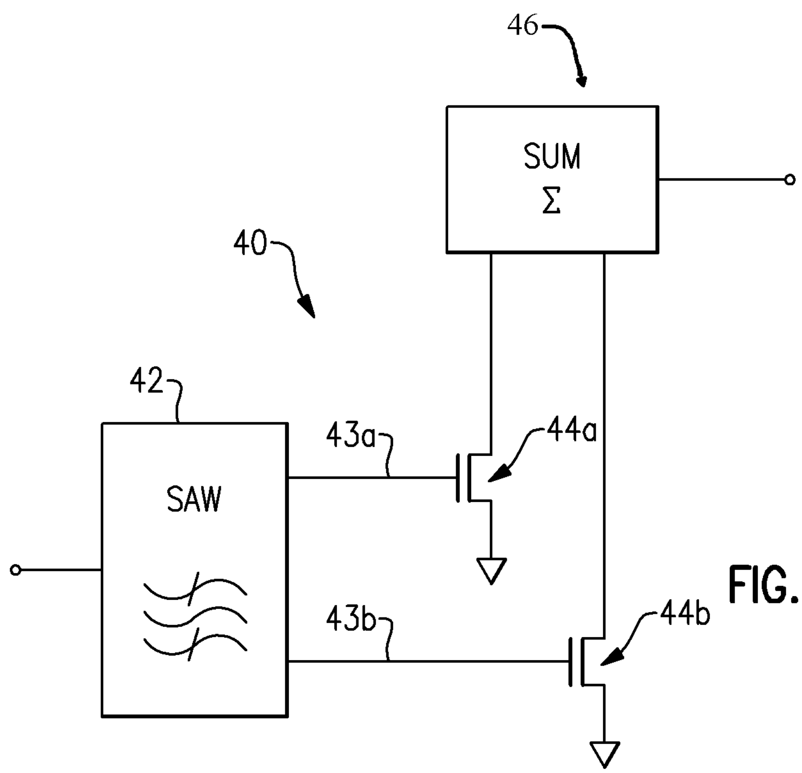

46
SUM
Σ
40
42
SAW
43a
44a
43b
44b

FIG.3

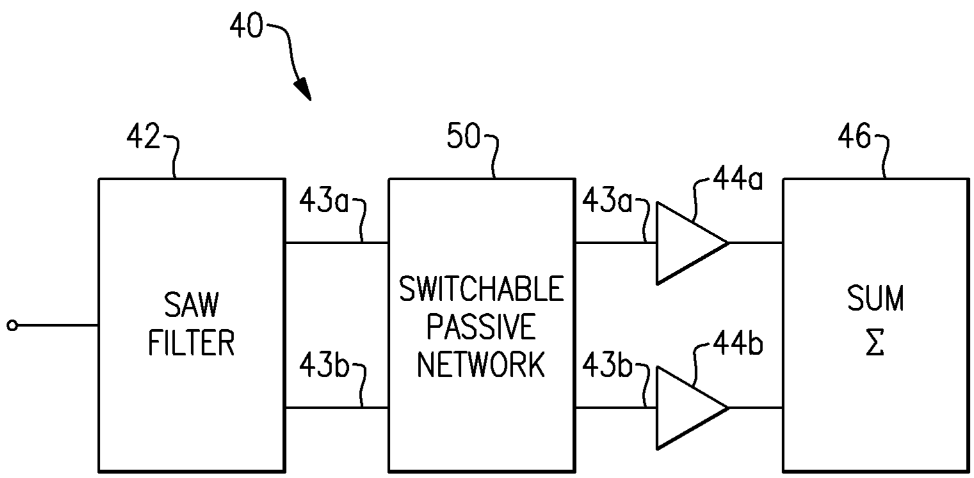

40
42
50
46
43a
44a
SAW
FILTER
SWITCHABLE
PASSIVE
NETWORK
SUM
Σ
43b
44b

FIG.4

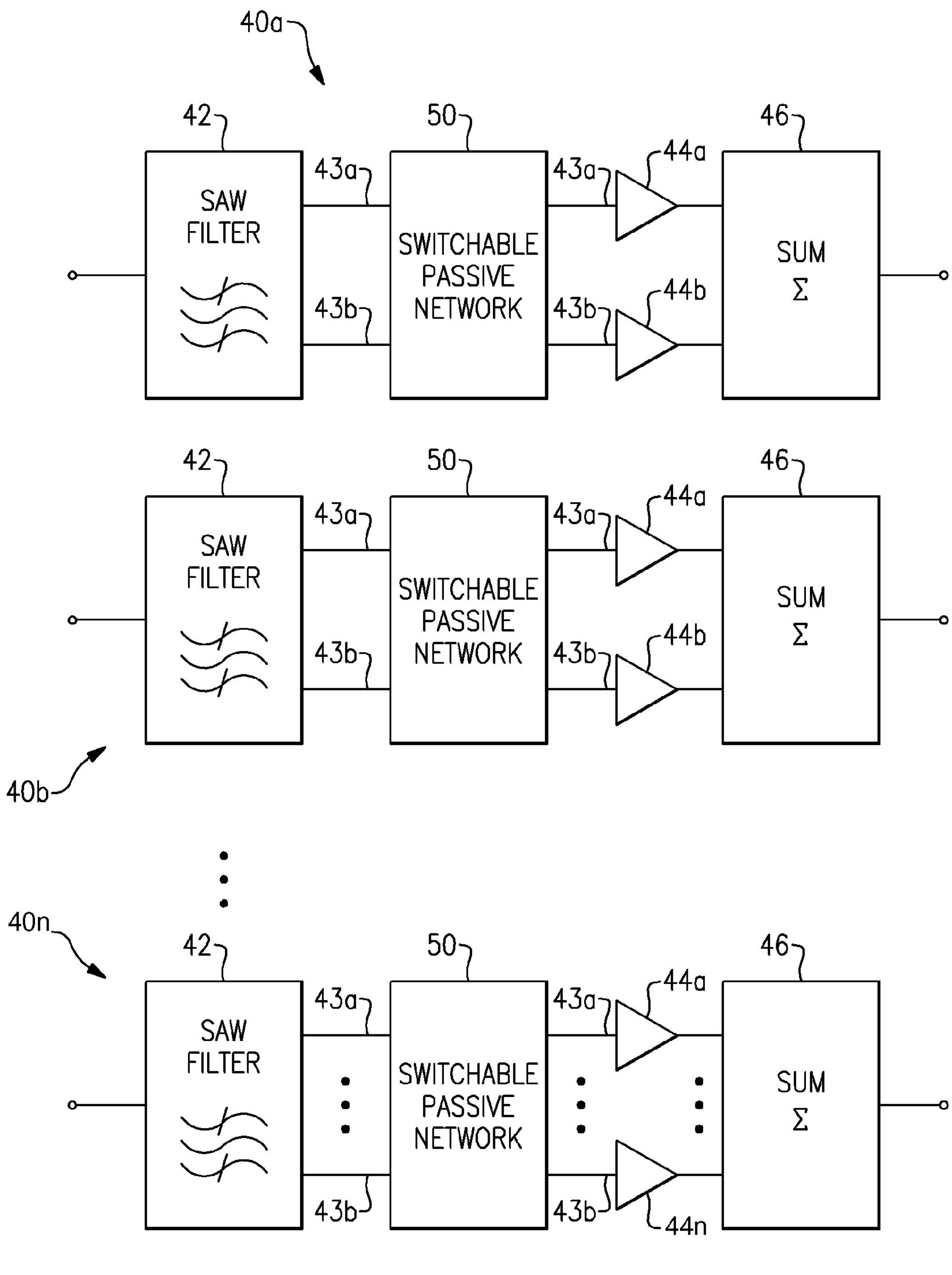

40a
42
50
46
SAW FILTER
43a
43b
SWITCHABLE PASSIVE NETWORK
43a
43b
44a
44b
SUM Σ
40b
40n
44n

FIG.5

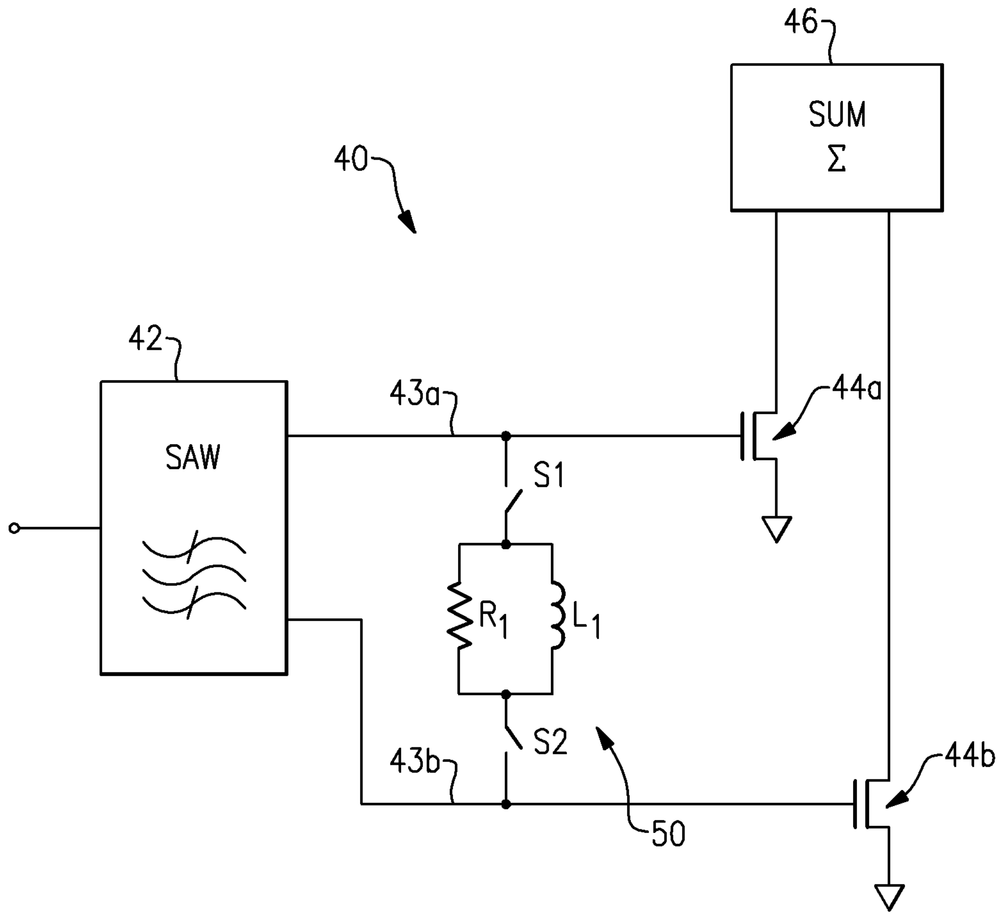


FIG.6

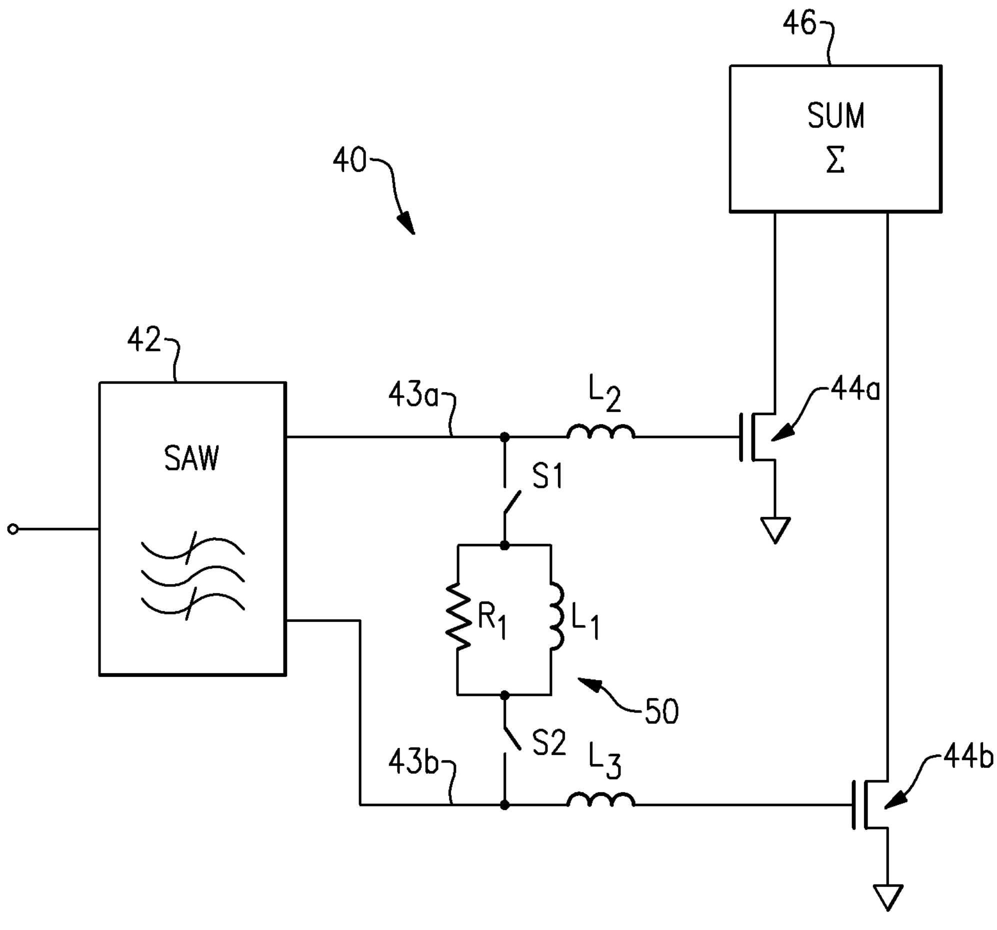


FIG.7

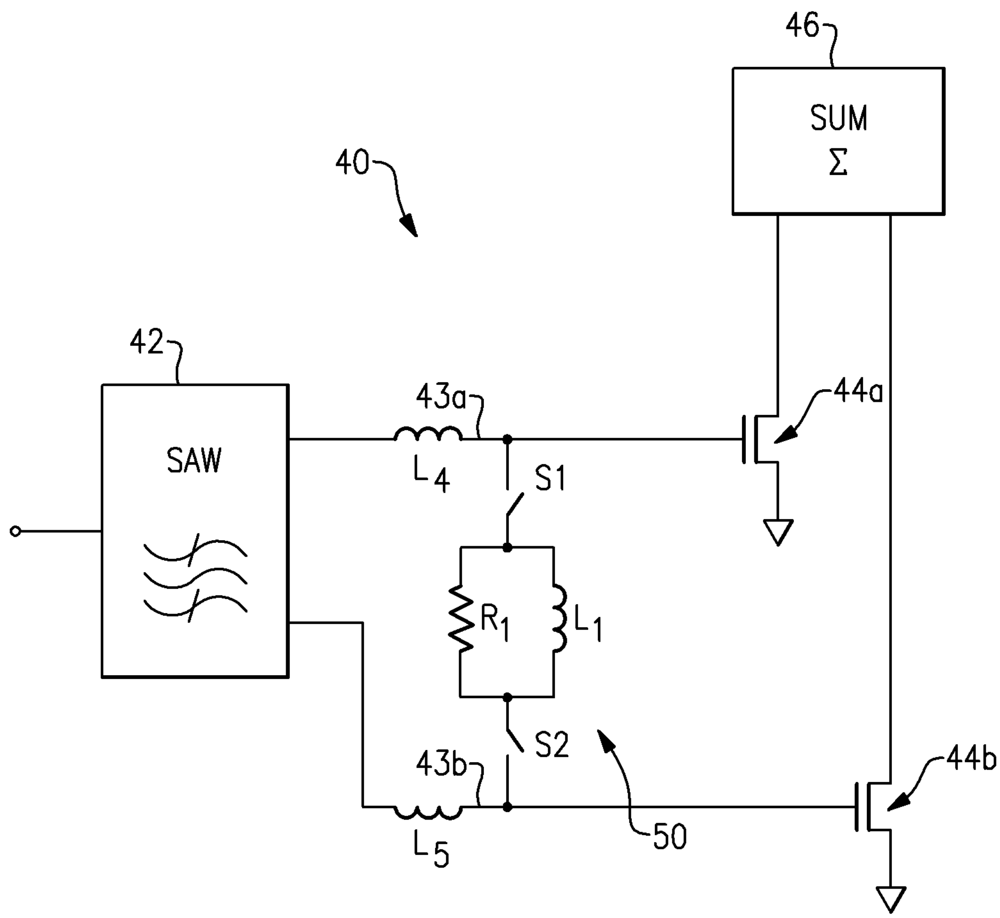


FIG.8

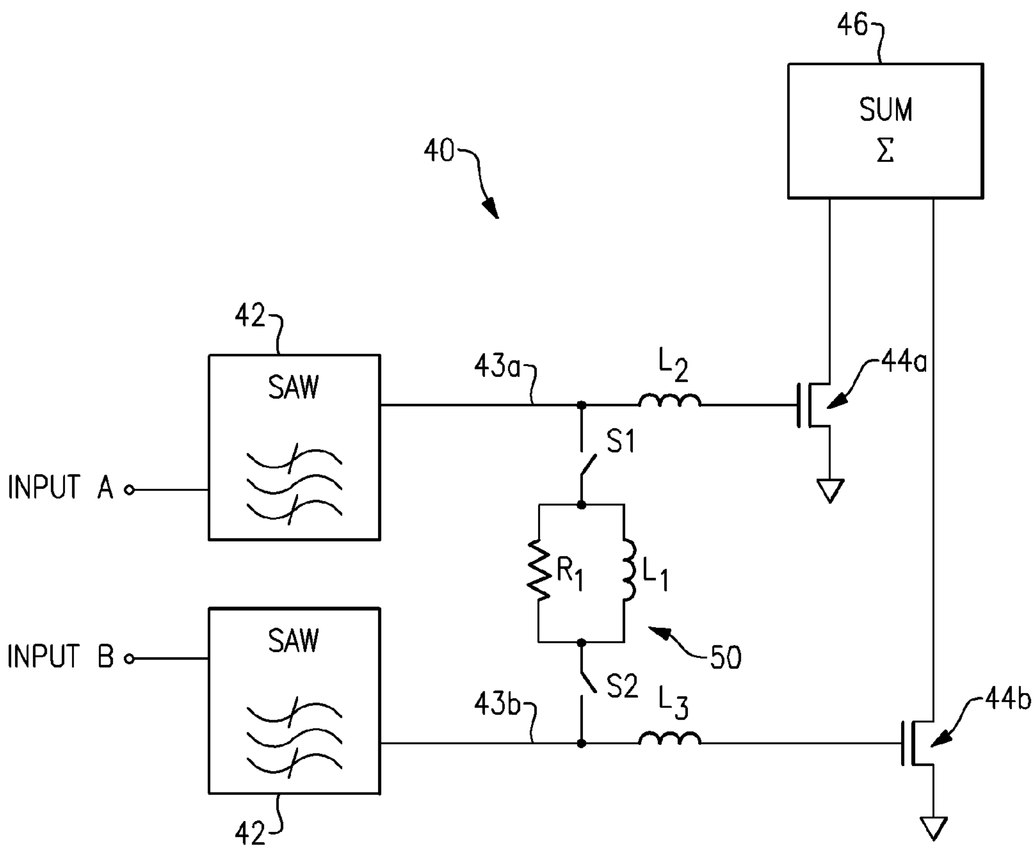

46
SUM
Σ
40
42
SAW
43a
L_2
44a
S1
INPUT A
R_1
L_1
50
INPUT B
SAW
S2
43b
L_3
44b
42

FIG.9

AGGREGATE SIGNAL AMPLIFICATION DEVICE AND METHOD

BACKGROUND

1. Field of the Invention

Embodiments of the invention relate to electronic systems and, in particular, to radio frequency (RF) electronics.

2. Description of the Related Art

RF electronics, such as cell phones, smart phones, tablets, computers, modems and other devices operate on a limited frequency spectrum. Various schemes are implemented to permit multiple devices to be transmitting and receiving on a particular frequency bands simultaneously. One such scheme is called carrier or channel aggregation which is currently used in 4G LTE Advanced implementations. In this scheme, wider transmission bandwidths are used to simultaneously transmit aggregated component carriers where the component carriers have different frequencies.

The component carriers can either be contiguous or non-contiguous frequencies. When multiple component carriers in different bands are aggregated and transmitted, they must be received using multiple bandpass filters, one for each band received. Such filters may be entirely independent from one another, or, coupled together at a common input point, such as at a common antenna.

Within the wireless receiving device, often the outputs of such filters must be amplified and re-combined onto a single path. An example of where this is done in a wireless device is the "diversity" receiver.

However, amplification and combining of these types of signals can result in significant noise and gain differences for signals among the different received frequency bands, which can affect overall signal quality. Hence, there is a need for an improved system and method of amplifying aggregated carrier component signals with reduced noise and improved gain characteristics.

SUMMARY

Certain embodiments disclosed herein provide a device for amplifying aggregate signals comprising: at least one filter that receives an aggregate signal having a plurality of signal components of different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs; a plurality of amplifiers that receive the plurality of sub-signals from the plurality of different outputs and amplify the plurality of sub-signals; and a network interposed between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output.

In one implementation the filter includes a surface acoustic wave (SAW) filter.

In one implementation, the surface acoustic wave (SAW) filter receives a diplex signal and outputs two signals onto two outputs that have different frequencies.

In another implementation the at least one filter includes a plurality of filters.

In another implementation, the plurality of amplifiers include low noise amplifiers formed of field effect transistors or bipolar junction transistors.

In one implementation the device further comprises a summing component that sums the amplified sub-signals.

In one implementation, the summing component includes a common node that receives the amplified sub-signals.

In one implementation, the network includes a passive network.

In one implementation, the passive network includes a resistor in parallel with an inductor.

In one implementation, the network includes at least one switch so that the passive network is selectively coupled between the plurality of outputs when sub-signals are being provided to the plurality of outputs and is selectively disengaged when only a single output signal is being provided to one of the plurality of outputs.

In one implementation, the at least one switch includes a plurality of switches that are respectively coupled to the plurality of outputs.

Certain embodiments disclosed herein provide a wireless device comprising: a receiver that receives wireless signals; a processor that controls the operation of the wireless device; at least one filter that receives an aggregate signal having a plurality of signal components of different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs; a plurality of amplifiers that receive the plurality of sub-signals from the plurality of different outputs and amplify the plurality of sub-signals; and a network interposed between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output.

In one implementation, the filter includes a surface acoustic wave (SAW) filter.

In one implementation, the surface acoustic wave (SAW) filter receives a diplex signal and outputs two signals onto two outputs that have different frequencies.

In one implementation, the at least one filter includes a plurality of filters.

In one implementation, the plurality of amplifiers include low noise amplifiers formed of field effect transistors or bipolar junction transistors.

In one implementation, the device further comprises a summing component that sums the amplified sub-signals.

In one implementation, the summing component includes a common node that receives the amplified sub-signals.

In one implementation, the network includes a passive network.

In one implementation the passive network includes a resistor in parallel with an inductor.

In one implementation, the network includes at least one switch so that the passive network is selectively coupled between the plurality of outputs when sub-signals are being provided to the plurality of outputs and is selectively disengaged when only a single output signal is being provided to one of the plurality of outputs.

In one implementation, the at least one switch includes a plurality of switches that are respectively coupled to the plurality of outputs.

In one implementation, the device includes a plurality of filters that receive aggregate signals.

Certain embodiments disclosed herein disclose a method of amplifying aggregate signals comprising: separating onto outputs aggregate signals having a plurality of signal components of different frequency bands into sub-signals of pre-selected frequency bands; amplifying the sub-signals; and interconnecting the outputs via an impedance network, the impedance network being selected so as to at least partially terminate portions of a sub-signal on an output having a frequency other than the pre-selected frequency band.

In one implementation, separating the aggregate signals includes separating the signals using a multiplex surface acoustic wave (SAW) filter.

In one implementation, amplifying the sub-signals includes amplifying the sub-signals using a low noise amplifier.

In one implementation, interconnecting the outputs via an impedance networks includes interconnecting the outputs via switches and a passive network.

In one implementation, the passive network includes a resistor in parallel with an inductor.

In one implementation, the method further comprises summing the amplified sub-signals.

In one implementation, separating the aggregate signals includes separating the signals using a plurality of filters to produce a plurality of sub-signals.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of a wireless device having a receiver having a filtering component of the present disclosure.

FIG. **2** is a schematic block diagram of an example wireless or network device that can include one or more of the modules of FIG. **1**.

FIG. **3** is a circuit diagram of a diplexing filter and amplifier circuit that can be used with the low-noise amplifier module of FIG. **1**.

FIG. **4** is a schematic block diagram of a diplexing filter and amplifier circuit with a switchable passive network that can be used with the low-noise amplifier module of FIG. **1**.

FIG. **5** is a schematic block diagram of an array of diplexing filters and amplifier circuits of FIG. **4**.

FIG. **6** is a circuit diagram of one implementation of a diplexing filter and amplifier circuit with a switchable passive network.

FIG. **7** is a circuit diagram of another implementation of a diplexing filter and amplifier circuit with a switchable passive network.

FIG. **8** is a circuit diagram of another implementation of a diplexing filter and amplifier circuit with a switchable passive network.

FIG. **9** is a circuit diagram of another implementation of a filter and amplifier circuit with a switchable passive network with a plurality of filters.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** is a schematic diagram of a wireless device **11** such as a cellular phone, smart phone, tablet, modem, communication network or any other portable or non-portable device configured for voice and/or data communication.

The device **11** includes an antenna **14** that receives signals such as multiplex signal and a filter component **24** that in one specific implementation derives component signals from a multiplex signal. However, as will be discussed below, the filter component **24** may comprise any of a number of different filter implementations. The component further includes a transceiver **13** that can be configured to receive and transmit signals in a known fashion and a battery **15** that provides power to the device **11**.

FIG. **2** illustrates the wireless device **11** in greater detail. As shown, the device **11** may receive signals from a plurality of antennas **14** including a main antenna, a diversity antenna and the like. The main antenna **14** may be selected via an antenna switch module **12** so that signals can be selectively transmitted and received. The antenna switch module **12** receives signals from the transceiver **13** via a power amplifier module **17**. The transceiver **13** is configured to generate transmit signals and/or process received signals.

In some embodiments, such transmission and reception functionalities can be implemented in separate components (e.g. a transmit module and a receiving module), or be implemented in the same module. The antenna switch module **12** can be configured to switching between different bands and/or modes, transmit and receive modes etc. As is also shown in FIG. **2**, the main antenna **14** both receives signals that are provided to the transceiver **13** via the antenna switch module **12** and also transmit signals from the wireless device **11** via the transceiver **13**, the power amplifiers **17** and the antenna switch module **12** in a known fashion.

The system of FIG. **2** further includes a power management system **19** that is connected to the transceiver **13** that manages the power for the operation of the wireless device. The power management system **19** can also control the operation of a baseband sub-system **21** and other components of the wireless device **11**. The power management system **19** provides power to the device **11** via the battery **15** in a known manner.

The baseband sub-system **21** is shown to be connected to a user interface **23** to facilitate various input and output of voice and/or data provided to and received from the user. The baseband sub-system **21** can also be connected to memory **25** that is configured to store data and/or instructions to facilitate the operation of the wireless device, and/or to provide storage of information for the user.

The power amplifiers **17** can be used to amplify a wide variety of RF signals. For example, one or more of the power amplifiers **17** can receive an enable signal that can be used to pulse the output of the power amplifier to aid in transmitting a wireless local area network (WLAN) signal or any other suitable pulsed signal.

Each of the power amplifiers **17** need not amplify the same type of signal. For example, one power amplifier can amplify a WLAN signal, while another power amplifier can amplify, for example, a Global System for Mobile (GSM) signal, a code division multiple access (CDMA) signal, a W-CDMA signal, a Long Term Evolution (LTE) signal, or an EDGE signal.

In certain embodiments, a processor can be configured to facilitate implementation of various processes described herein. For the purpose of description, embodiments of the present disclosure may also be described with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems) and computer program products.

It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, may be implemented by computer program instructions. These computer program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the acts specified in the flowchart and/or block diagram block or blocks.

In certain embodiments, these computer program instructions may also be stored in a computer-readable memory **29** that can direct a computer or other programmable data processing apparatus to operate in a particular manner, such that the instructions stored in the computer-readable memory produce an article of manufacture including instruction means which implement the acts specified in the flowchart and/or block diagram block or blocks.

The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operations to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions that execute on the computer or other programmable apparatus provide steps for implementing the acts specified in the flowchart and/or block diagram block or blocks.

As is also shown in FIG. **2**, the wireless device **11** can also include a filter and amplifier element **24** that is adapted in one specific instance to receive a first input signal and filter the signal into one or more output signals and amplify the output signals.

In one specific implementation, the filter and amplifier element **24** receives an aggregate carrier or channel signals that comprise component signals transmitted on a bandwidth. The element **24** may be part of the RF front end or may be interposed between the RF front end and the transceiver **13**. Regardless, the element **24** receives, in one implementation, a multiplex signal such as a diplex signal that is comprised of more than one frequency band where the signals are aggregated. This allows for greater transmission of data and signals. Often, the signals will need to be amplified prior to the signals being used. The implementation shown in FIG. **2** is simply exemplary and should be non-limiting.

More specifically, as shown in FIG. **2** the wireless device **11** may include the element **24** that receives signals from an antenna **14**. The element **24** includes a filter **42** such as a multiplex filter that receives an aggregate signal that comprises a plurality of signal components. The filter **42** then separates the aggregate signals into the signal components on different frequency bands and provides this to low noise amplifiers **44** via a network **50** that is preferably switchable.

As will be described in greater detail below, the network **50** is designed to terminate or at least attenuate portions of the component signals that fall outside of the frequency band of the component signals to reduce noise and improve signal performance. The output of the amplifiers **44** can then be provided directly to the transceiver **13** or can be summed via summing component **46**.

It should be noted that in FIG. **2**, the element **24** is receiving the signal from a diversity antenna **14**. However, the element **24** can also receive signals from a main antenna **14** or can be implemented in any of a number of different manners without departing from the present teachings.

FIG. **3** is an exemplary circuit **40** of an amplifier circuit **40** for an aggregated signal. As shown, the circuit **40** includes a filter **42**, e.g., a diplex filter that receives the multiplex signal from, for example, the antenna **14**. The diplex filter **42** can comprise, in one non-limiting implementation, a surface acoustic wave (SAW) filter that receives the diplex signal and outputs two separate signals on two separate frequency bands on outputs **43***a*, **43***b*. The outputs are then fed into the gate of a low noise amplifying transistor **44***a*, **44***b* which results in an amplified signal that can then be either provided directly to another circuit component or the amplified signals can be provided to a summing circuit or amplifier **46**. The summing circuit **46** can then provide a summed output signal.

In one exemplary implementation, the low noise amplifying transistors **44***a*, **44***b* are depicted as FET-type transistors. It will be appreciated, however, that the application should not be limited to simply FET-type transistors as any of a number of different types of amplifying devices can be used without departing from the scope of the present disclosure. For example, bipolar junction transistor applications can also be used without departing from the scope of the present teachings.

In one implementation, the summing circuit **46** comprises a common node that receives the signals from the transistors **44***a*, **44***b* but other implementations are also possible without departing from the scope of the present invention. The multiplex filter **42** can be receiving the input signal from the antenna **14** or from the RF front end **12** or any other component and the summing circuit **46** can be providing the amplified signal to the RF front end **12**, to the antenna **14** or any other component depending upon the implementation. Again, a person of ordinary skill in the art will appreciate that the component can be implemented in any of a variety of different configurations of a wireless device.

One difficulty that occurs with the circuit of FIG. **3** is that there can be substantial noise and difference gain on each of the frequency bands of the output of the multiplex filter **42**. This occurs as a result of the signals on one band back coupling to the low noise amplifier inputs **44***a*, **44***b* and reflecting at the multiplex signal filter **42** in the aggregated band. This occurs because, at frequencies other than the intended pass bands of the multiplex filter **42**, the filter **42** outputs are highly reflective which results in significant gain variation.

Further, the low noise amplifiers will only give low noise figures when the source impedance is correctly matched. If the input of the low noise amplifiers **44***a*, **44***b* are presented with a very reflective source impedance in the aggregate frequency bands, the output noise of the low noise amplifier **44***a*, **44***b* can be very high which degrades circuit performance.

In order to address these issues, a switchable network **50**, such as a passive network, can be implemented between the multiplex filter **42** and the low noise amplifiers **44***a*, **44***b*. The switchable network **50** is preferably tuned so that the network **50** provides for mutual termination of the portion of the signal that is being reflected. In other words, the portion of the signal on each of the outputs **43***a*, **43***b* that has a frequency component that falls outside of the band for the output **43***a*, **43***b* is preferably terminated or attenuated by the network **50**.

The switchable network **50** can comprise a network of passive components, such as resistors, capacitors and inductors and can also include shunts etc. or even in some implementations active devices. The network **50** is preferably tuned so that the portion of a signal on one of the outputs **43** that is not the correct frequency band for that output **43***a*, **43***b* is terminated or at least attenuated by the network **50**.

Preferably, the network **50** is switchable such that the network can be selectively connected and disconnected between the two outputs **43**. This permits the use of either output **43** when a non-aggregate signal is being passed by the filter **42** with the losses introduced by the network **50** reduced as a result of the network being switched out of the circuit. However, when the filter **42** is passing an aggregate signal on one or more of the outputs **43**, the passive network **50** can be switched between the two outputs **43** thereby allowing the termination of the portion of the signals on the outputs that would otherwise cause noise and gain inconsistencies.

FIG. **5** is another implementation of the filter component **24** shown in FIG. **2**. As illustrated, the filter component **24** can actually comprise a plurality of circuits components **40** each comprising a multiplex filter **42**, a switchable passive network **50**, amplifiers **44***a*, **44***b* and summing components **46**. Further, the plurality of multiplex filters **42** may also comprise multiplex filters **42** that a diplex filters or filters that receive aggregate signals having more than two different discrete bands as demonstrated by the bottom most filter **40***n*.

Any other filter or set of filters that have multiple outputs can also be used without departing from the spirit of the present teachings. Preferably, there is a switching network **50***n* that has multiple passive components such that the unwanted signal components on each of the outputs **43** can be terminated in the manner described above and the outputs can be provided to multiple transistors **44***a*-**44***n*. The exact configuration of the filter component **24** can vary depending upon the implementation.

FIG. **6** is a specific exemplary circuit implementation of a filter component **40** that includes a SAW filter **42** having two outputs **43***a*, **43***b* that drive the gate of transistors **44***a*, **44***b* that function as low noise amplifiers. The drains of the transistors **44***a*, **44***b* are provided to a summing circuit **46** which, as discussed above, can comprise a common node that is connected to each transistor **44***a*, **44***b*.

In this implementation, the switching passive network **50** comprises a resistor R**1** in parallel with an inductor L**1** that is connected to the outputs **43***a* and **43***b* via switches that are controllable via the processor **20** or control **18** (See, FIG. **2**). When an aggregate signal having two frequency bands is received by the SAW **42**, the SAW **42** outputs discrete signals on the outputs **43***a*, **43***b*.

To amplify both signals, transistors **44***a* and **44***b* are both enabled. An undesired effect occurs where the signal of each band back-couples to the opposite-band low noise amplifier input, and reflects off the port of the opposite-band filter of the multiplex filter **42**, thereby causing some signal power to be added or subtracted from the original signal. This results in significant gain variation. To correct this, the switches S**1** and S**2** are closed and the parallel resistor and inductor network terminates or reduces the unwanted reflected signal component.

Notably, the network does not substantially terminate the desired forward signal component, because the opposite end of the network is tied to the reflective impedance presented by the opposite-band filter port. Effectively the network appears as a tuning stub to the desired forward signal component. Therefore any excess loss of the desired signal is minimized. This results in a cleaner signal being provided to the amplifiers **44***a*, **44***b* and to the sum circuit component **46**.

In circumstances where the SAW **42** is not providing an aggregate signal, the switches can be disabled so that the losses on the transmission of the non-aggregate signal to the low noise amplifiers **44***a*, **44***b* can be reduced.

FIGS. **7** and **8** further illustrate other implementations. In the implementation of FIG. **7**, an impedance match network comprising an inductor L**2** and L**3** may be added between the low noise amplifiers **44***a*, **44***b* and the switches S**1** and S**2** so as to provide the best possible noise figure for the amplifiers **44***a*, **44***b*. Similarly, in FIG. **8**, inductors L**4** and L**5** can also be added between the switches S**1** and S**2** and the SAW **42** for the same purpose. The switched network **50** can thus be implemented either before or after the matching components that are selected to reduce the noise figure for the amplifiers **44***a*, **44***b*.

FIG. **9** illustrates that the noise and gain problems discussed above in conjunction with FIG. **3** may also be present if two entirely separate filters **42** are used. As shown in FIG. **9**, two separate filters **42** provide outputs **43***a*, **43***b* and the outputs are connected via a switching network **50** in the same manner as described above. To the extent that there are components on one of the outputs **43***a*, **43***b* of the separate filters **42** that are not within the frequency band for the output **43***a*, **43***b*, the switchable network **50** can be used to terminate those unwanted signals to lower noise and improve gain difference between the outputs.

As preceding discussion has provided example implementations described in connection with SAW devices. However, it should be appreciated that any filter or set of filters, irrespective of construction, may present an unterminated impedance to the circuit out of their respective pass band. As such the output **43***a*, **43***b* may be receiving outputs of different types of filters and the unterminated impedances can similarly be terminated by an appropriately designed switchable network **50** within the scope of the present disclosure.

While the foregoing has shown, illustrated and described various implementations and uses of the present invention, a person of ordinary skill in the art will appreciate that various changes, substitutions and modifications to the embodiments described herein can be made by those skilled in the art without departing from the scope and spirit of the present invention. Hence, the present invention should not be limited to the foregoing descriptions but should be defined by the appended claims.

What is claimed is:

1. A device for amplifying aggregate signals comprising:

at least one filter that receives either an aggregate signal having a plurality of signal components of different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs or an non-aggregate signal having a single signal component that is provided to at least one of the plurality of outputs;

a plurality of amplifiers that are connected to the plurality of outputs to receive the plurality of sub-signals from the plurality of different outputs and amplify the plurality of sub-signals; and

a network connected between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output the network being switchable between a first configuration where the network components are terminating at least a portion of the signals on the plurality of outputs when an aggregate signal is received and a second configuration where the network components are not terminating at least a portion of the signal on the plurality of outputs when a non-aggregate signal is received.

2. The device of claim **1** wherein the filter includes a surface acoustic wave (SAW) filter.

3. The device of claim **2** wherein the surface acoustic wave (SAW) filter receives a diplex signal and outputs two signals onto two outputs that have different frequencies.

4. The device of claim **2** wherein the at least one filter includes a plurality of filters.

5. The device of claim **1** wherein the plurality of amplifiers include low noise amplifiers formed of field effect transistors or bipolar junction transistors.

6. The device of claim **1** further comprising a summing component that sums the amplified sub-signals.

7. The device of claim **6** wherein the summing component includes a common node that receives the amplified sub-signals.

8. The device of claim 1 wherein the network includes a passive network.

9. The device of claim 8 wherein the passive network includes a resistor in parallel with an inductor.

10. The device of claim 8 wherein the network includes at least one switch so that the passive network is selectively coupled between the plurality of outputs when sub-signals are being provided to the plurality of outputs and is selectively disengaged when only a single output signal is being provided to one of the plurality of outputs.

11. The device of claim 10 wherein the at least one switch includes a plurality of switches that are respectively coupled to the plurality of outputs.

12. A wireless device comprising:
- a receiver that receives wireless signals;
- a processor that controls the operation of the wireless device;
- at least one filter that receives either an aggregate signal having a plurality of signal components of different frequency bands and separates the aggregate signal into a plurality of sub-signals of different frequency bands onto a plurality of outputs or a non-aggregate signal having a single signal component that is provided to at least one of the plurality of outputs;
- a plurality of amplifiers that are connected to the plurality of outputs to receive the plurality of sub-signals from the plurality of different outputs and amplify the plurality of sub-signals; and
- a network connected between the plurality of outputs, the network having components selected to terminate at least a portion of the signals on the plurality of outputs that have a frequency outside of the frequency band corresponding to the output the network being switchable between a first configuration where the network components are terminating at least a portion of the signals on the plurality of outputs when an aggregate signal is received and a second configuration where the network components are not terminating at least a portion of the signal on the plurality of outputs when a non-aggregate signal is received.

13. The device of claim 12 wherein the filter includes a surface acoustic wave (SAW) filter.

14. The device of claim 13 wherein the surface acoustic wave (SAW) filter receives a diplex signal and outputs two signals onto two outputs that have different frequencies.

15. The device of claim 12 wherein the at least one filter includes a plurality of filters.

16. The device of claim 12 wherein the plurality of amplifiers include low noise amplifiers formed of field effect transistors or bipolar junction transistors.

17. The device of claim 12 further comprising a summing component that sums the amplified sub-signals.

18. The device of claim 17 wherein the summing component includes a common node that receives the amplified sub-signals.

19. The device of claim 12 wherein the network includes a passive network.

20. The device of claim 19 wherein the passive network includes a resistor in parallel with an inductor.

21. The device of claim 19 wherein the network includes at least one switch so that the passive network is selectively coupled between the plurality of outputs when sub-signals are being provided to the plurality of outputs and is selectively disengaged when only a single output signal is being provided to one of the plurality of outputs.

22. The device of claim 21 wherein the at least one switch includes a plurality of switches that are respectively coupled to the plurality of outputs.

23. The device of claim 12 wherein the device includes a plurality of filters that receive aggregate signals.

24. A method of amplifying aggregate signals comprising:
- receiving either aggregate signals having a plurality of signal components having different frequency bands or non-aggregate signals having a single signal component
- separating onto outputs aggregate signals having a plurality of signal components of different frequency bands into sub-signals of pre-selected frequency bands;
- amplifying the sub-signals; and
- selectively interconnecting the outputs via an impedance network, the impedance network being selected so as to at least partially terminate portions of a sub-signal on an output having a frequency other than the pre-selected frequency band when an aggregate signal is received; and
- disconnecting the outputs via the impedance network when a non-aggregate signals is received.

25. The method of claim 24 wherein separating the aggregate signals includes separating the signals using a multiplex surface acoustic wave (SAW) filter.

26. The method of claim 24 wherein amplifying the sub-signals includes amplifying the sub-signals using a low noise amplifier.

27. The method of claim 24 wherein interconnecting the outputs via an impedance networks includes interconnecting the outputs via switches and a passive network.

28. The method of claim 27 wherein the passive network includes a resistor in parallel with an inductor.

29. The method of claim 24 further comprising summing the amplified sub-signals.

30. The method of claim 24 wherein separating the aggregate signals includes separating the signals using a plurality of filters to produce a plurality of sub-signals.

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